AN EVALUATION OF THE RAIL RATE TO VARIABLE COST RATIO AS A CRITERION FOR MARKET DOMINANCE

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Abstract. It is shown that the optimal rate to variable cost ratio for rail shipments of grain from a central Illinois region can change considerably in response to stochastic changes in barge rates. The use of this ratio as a market dominance standard may be misleading, particularly during periods of high barge rates.

An Evaluation of the Rail Rate to Variable Cost Ratio as a Criterion for Market Dominance

With the passage of the Railroad Revitalization and Regulatory Reform Act (4-R Act) in 1976, "market dominance" became a central issue in determining the need for rail rate regulation for specific cases. Although semantically unclear, the 4-R Act refers to market dominance as "an absence of effective competition from other carriers or modes for the traffic or movement to which the rate applies." (Public Law 94-10, sect. 202(b)). After the general concept of market dominance was established, the Interstate Commerce Commission (ICC) defined three rebuttable presumptions of market dominance (Ex Parte No. 320) to be used in determining the "reasonableness" of rail rates. The purpose of these rebuttable presumptions was to allow less economic regulation although their deregulatory effectiveness was not great. In contrast, the Staggers Act of 1980 gave railroads tremendous freedom in setting rates by simply allowing most rates to vary unconditionally between maximum and minimum rate to variable cost (R-VC) ratios.

The economic rationale for using R-VC ratios as a standard of "competitiveness" presumably reflects the idea that, in general, firms within a competitive industry face a very elastic demand hence their R-VC ratios will usually be relatively small, as opposed to "non-competitive" industries in which the firms face less elastic demands and set prices such that the R-VC ratio is high.

The general objectives of this paper are (a) to estimate levels of R-VC ratios for grain shipments from a specific region to one destination and (b) to examine the sensitivity of these R-VC estimates to barge rate levels. It is shown that the R-VC for the physical infrastructure defined can change considerably in response to stochastic rate conditions of the competing mode and that elasticity and R-VC estimates may be very misleading in determining the competitiveness of grain transportation in specific cases.

Analysis

There are, of course, many types of competition facing railroads--inter- and intramodal competition from one origin to one destination; competition among destinations; interregional competition (between regions within the U.S. as well as regions throughout the world) for a market; interproduct competition; and others. In this study, an attempt is made to isolate a case where the prevailing type of competition in the short run is simply between rail and barge for one market. The area chosen for analysis is the central Illinois region delineated in Figure 1. It is assumed that the amount of corn and soybeans available for export-bound shipments will be transported to the Gulf ports via rail or barge.

A very simple demand model is developed for grain (corn and soybeans) rail shipments by determining the boundary line at which on one side the grain is transported by barge and on the other side the grain is transported by rail. The boundary line is found under the assumption that the grain moves from the farm to either a rail loading point or a barge loading point, depending on which route yields the lowest cost of transportation from the farm to the Gulf.

This simulation type model is used instead of an econometric model because shipment data are not available. In a sense, the model used represents an alternative to an optimization model. The tradeoff between using this study's methodology and, say, a linear programming (L.P.) model

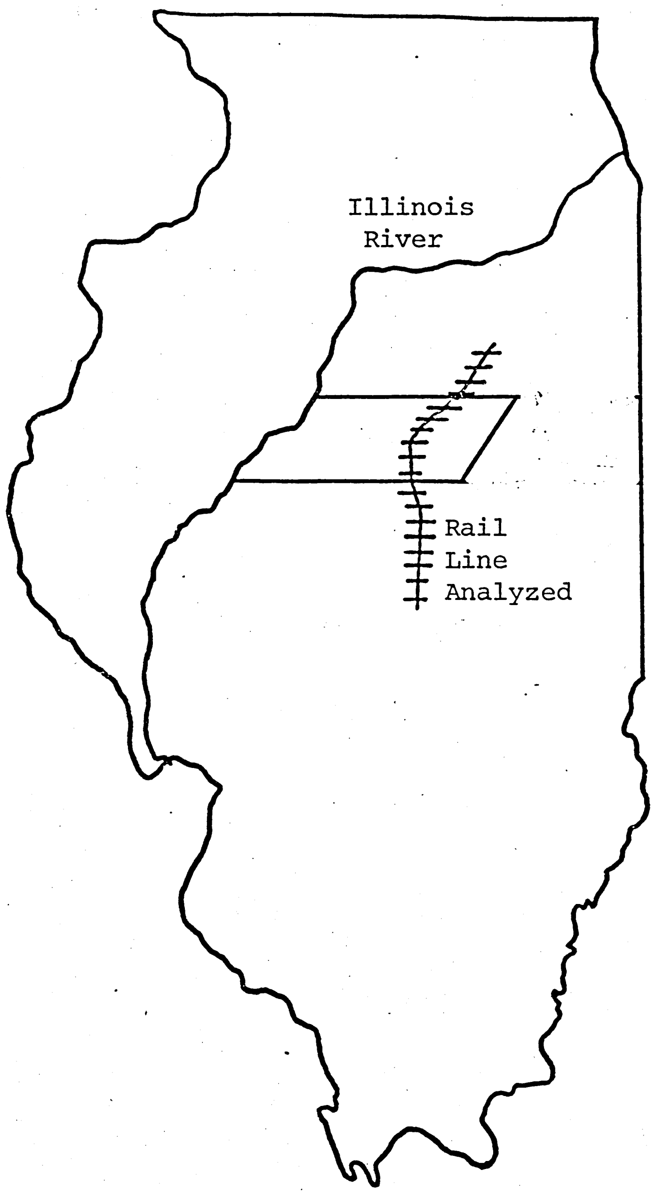

Figure 1. Region of Analysis

is that the L.P. model would reflect interregional source and sink effects but at the expense of larger modelling costs and at the expense of losing sensitivity from using "all or nothing shipment" regions. Hence, a case example is chosen such that, in the opinion of the authors, there are virtually no interregional effects. Given that a change in barge or rail rate causes only a modal change, then the slope of the rail shipment demand can be measured more accurately (under the assumption of least-cost shipments) by using a model which allows continuous changes in the competitive boundary line.

The competitive boundary is determined when

(1) $B + a + bm = R + a + b(w-m)$,

where B is the barge rate for the region in cents per ton; $a + bm$ is a linear truck rate function with coefficients a and b; m is one-way air miles from the farm to river; R is the rail rate; and w is mileage length between the river and rail line. Barge rates are based on trades made at the St. Louis Merchants Exchange Call Session; the truck rate function is based on cost data for 1980; and, given R, m is determined as

(2) $m = .5Rb^{-1} - .5Bb^{-1} + .5w$.

Given m, the quantity shipped by rail, Q, is

(3) $Q = (w-m)PH + E$,

where Q is tons of grain transported by rail; P is the production density per square mile available for export; H is the north-south distance of the region[1]; and E is the tons available for export in the region east of the rail line. The values of P and E are based on the grain flow survey work by Hill et al. and Leath et al. The eastern border of the region approximately bisects the region between the rail line of analysis and the competing major north-south rail line. This eastern border is defined under the assumption that the two lines' rates are always equal.

The first rate scenario considered is one in which the barge rate is equal to estimated average annual barge rate (Neff) during 1980. The equilibrium R is determined such that marginal revenue (MR) is equal to marginal cost (MC). The MC estimate is equal to the average variable cost[2] (assumed constant[3]) for Gulf-bound 115-car corn shipments from central Illinois. Under these conditions, the optimal rate to marginal revenue ratio is the optimal R-VC ratio. The slope $(-PH.5b^{-1})^{-1}$ of the 1980 demand is -.826; the optimal point elasticity $(\frac{\partial Q}{\partial R} \frac{R}{Q})$ is -2.31; m is 36.85 miles; Q is 785,000 tons; the optimal rail rate is 1500 cents per ton; and the resulting R-VC ratio is 1.46.

Past studies of demand for grain rail shipments (eg., Berger and Nelson; Fitzsimmons; Fuller, Makus, and Taylor; Fuller and Shanmughan; Hoffman; Johnson; Johnson and Mennem; Levin; and W. Wilson) have varied considerably by method, region, commodity, variable (even rate) definition, functional form, time period, etc. The range of demand elasticities in the studies cited above is from -.03 (Wilson) to -8.14 (Berger and Nelson); however, most studies have found inelastic (greater than -1) demands. Thus, the demand found here is more elastic than that generally found and probably due to the study's micro orientation and to the proximity of the region relative to the river.

The R-VC (1.46) is relatively high when compared to the estimates of Fuller, Makus, and Taylor. However, the Fuller et al. estimates are based on average costs at a much higher level (based on discussion with Stephen Fuller) than the costs used in this study. Indeed, our R-VC estimates for this region are very close to Fuller et al.'s when we use their cost estimates.

The 1980 example described above is somewhat misleading because it is for only one barge rate level. In reality, barge rates are quite variable and a change in barge rate shifts the rail demand and causes a change in the optimal rail rate, R-VC, elasticity, etc. For example, the demand characteristics for the same conditions as above with different barge rates are shown in Table 1. The alternative barge rate levels are annual averages for 1978-1982. Since the barge rate change shifts the rate intercept of rail demand by the amount of the change, then the optimal change in rail rate is one-half the change in barge rate and the proportional change in R-VC will equal the proportional change in rail rate. Thus, the positive relationship between R-VC and barge rate is known a priori. The important question concerns the magnitude of R-VC changes occuring in response to "common" barge rate changes. When simply using the average annual barge rates for the 1978-1982 period (under 1980 cost and grain surplus conditions), the R-VC ranges from 1.22 to 1.49.

Another perspective is gained when we consider R-VC changes within a year. To measure barge variability during one season, we start with Neff's strong evidence that barge rates for the Illinois River are generated by a standard Gauss-Wiener process. Given this process under the assumption of no systematic or known drift, the variance of $\ln \left(\frac{Bt + \Delta t}{Bt}\right)$ is found, where Bt is the barge rate at time t and Δt is the change in t. The resulting variance estimates $\sigma^2 \Delta t$, where σ^2 is the variance of $\ln \left(\frac{Bt + \Delta t}{Bt}\right)$ when Δt is an instant. Implicit when estimating $\sigma^2 \Delta t$ is that σ^2 is constant over time.

For this analysis, the Δt used to estimate σ^2 represents approximately one week because an adequate number of observations is then provided from the Merchant Exchange Call Session's relatively thin market. The variance

Table 1. Rail Demand Characteristics Under Alternative Annual Barge Rate Levels.[a]

Year	Average Barge Rate	Elasticity	Boundary Line (m)	Rail Shipments (Q)	Rail Rate (R)	Rate to Cost (R-VC)
1978[b]	866	-2.77	47.0	582	1332	1.30
1979	1251	-2.27	35.4	814	1525	1.49
1980	1203	-2.31	36.9	785	1500	1.46
1981	962	-2.61	44.1	640	1380	1.35
1982	698	-3.14	52.0	481	1248	1.22

[a] The average variable cost is 1026 cents per ton; the demand slope is -.826; m is in miles from the river; Q is in thousand tons; and R is in cents per ton.

[b] The 1978 barge rate average is based on observations during August-December because barge trading at the Call Session did not begin until August 1978.

Table 2. Rail Demand Characteristics Under Alternative Intrayear Barge Rate Levels.[a]

Lag (weeks)	Barge Rate[b]	Elasticity	Boundary Line (m)	Rail Shipments (Q)	Rail Rate (R)	Rate to Cost (R-VC)
1						
	1082	-2.45	40.5	712	1440	1.40
	1332	-2.20	33.0	862	1565	1.53
4						
	976	-2.59	43.7	648	1387	1.35
	1476	-2.08	28.7	949	1638	1.59
16						
	793	-2.92	49.2	538	1296	1.26
	1818	-1.89	18.4	1155	1808	1.76

[a] See footnote a of Table 1.

[b] The high and low barge rates for each lag are based on the variance of the log returns for one-week lags under the assumptions described in the text. The rates are derived from returns which are one standard deviation from the mean.

of the log-price weekly differences for August 1982 through April 1983[4] is .1035. This estimate is then used to derive the standard deviations for one-, four-, and sixteen- week lags under the assumption that σ^2 is constant. Given these standard deviations, the range of barge rates expected within one standard deviation are shown in Table 2 with their respective rail demand characteristics.

Since no drift is assumed, the barge ranges are centered by the average 1980 barge rate of 1202 cents per ton. An interesting point illustrated here is that, given the variability characteristics measured, the R-VC range within one standard deviation is .24 (or 17.8%) for only a four week period. The range is much larger for a 16 week period but probably less reliable because of the likelihood that σ^2 is a function of rate level and not constant. Nonetheless, it is obvious that R-VC can vary considerably within a short period of time in response to barge rate changes representative of past rate behavior.

Concluding Remarks

The purpose of this paper is <u>not</u> to prove or disprove market dominance by railraods for a specific case. Rather, the purpose is to investigate, through the use of simple economic concepts, the magnitude of change in the R-VC levels which can occur due to realistic changes in barge rates. As shown in Table 2, these R-VC chnges can be quite large. Indeed, barge rates of 793 and 1818 cents per ton (which have both been realized) causes the R-VC to be 1.26 and 1.76, respectively. According to the ICC threshold standard of market dominance (R-VC of 1.8), this case area exhibits a "non-competitive" structure during times of high barge rates and a competitive structure during periods of low barge rates. Although factors other than R-

VC can be considered in ICC litigation, it is clear that the R-VC criterion by itself can be very misleading in determining market dominance.

Footnotes

[1] A constant H implies that changes in rail rates do not affect the drawing area on the north and south boundaries. This is not unreasonable if one assumes equal changes in rail rates for all points (including those points outside the region of analysis) on the rail line.

[2] The average variable cost was calculated by the Upper Great Plains Transportation Institute. The Institute's costing program is based on ICC costs; however, product categories are more specific than the ICC categories. The authors wish to thank Denver Tolliver for estimating the mid-1983 cost. This cost was deflated to 1980 with the Association of American of Railroad's (1982,1983) cost indexes.

[3] G. Wilson notes that most studies have shown constant average costs for rail shipments after a relatively small quantity transported (p. 12).

[4] The barge rates are for next-week shipments from the Illinois River to the Gulf. The August 1982-April 1983 period was chosen because of the active trading during this period.

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